DICOM Conformance Statement

Document Version
- 04 -

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1. INTRODUCTION 4

2. QUICK SUMMARY 5

3. STORING STUDIES 7

3.1 IDEAL STORE SCENARIO 7
3.2 NON-IDEAL SCENARIOS 7
3.2.1 Accession number 8
3.2.2 No indication of completion 8
3.3 CSTORE 9
3.4 MODALITY WORKLIST 10
3.5 STORAGE COMMITMENT 11
3.6 PERFORMED PROCEDURE STEP 12

4. RETRIEVING STUDIES 13

4.1 C-FIND 13
4.1.1 Matching attributes 13
4.2 C-MOVE 14
4.2.1 Matching Attributes 14

5. DICOM PRINT SCU 16

5.1 OVERVIEW 16
5.2 REQUIRED SOP CLASSES 16
5.3 OPTIONAL SOP CLASSES 16
5.4 SUPPORTED DICOM ATTRIBUTES 16

1. Introduction

This is a DICOM conformance statement for FUJIFILM Medical Systems USA's Synapse® PACS System.

Synapse® PACS system contains one or more instances of Dicom Server application which provides all the necessary services as a DICOM Service class provider.

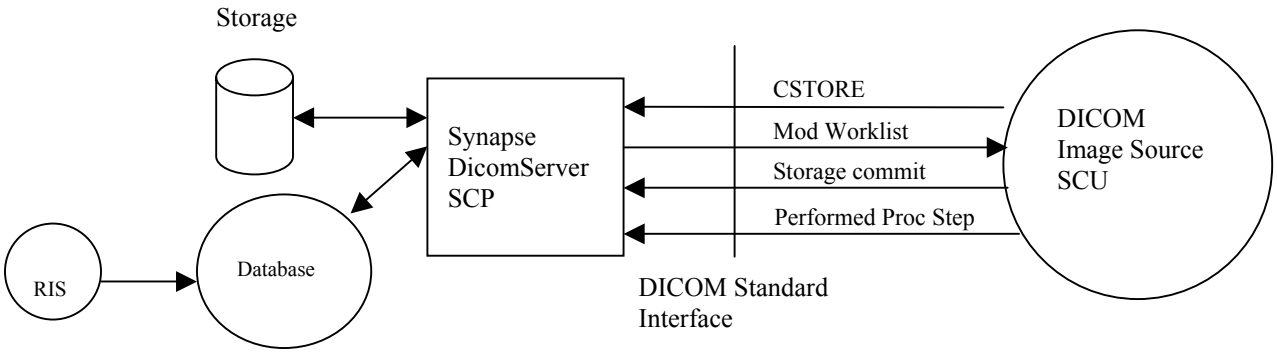
The Dicom Print SCU capability is provided through a separate Dicom Printer driver, which installs a Dicom printer within the Windows NT environment.

2. Quick Summary

SOP Class Name	SOP UID	Transfer Syntax UID	Comments
Verification	1.2.840.10008.1.1	1.2.840.10008.1.2	
Standard storage	1.2.840.10008.5.1.4.1.1.1 (CR) 1.2.840.10008.5.1.4.1.1.2(CT) 1.2.840.10008.5.1.4.1.1.3(retUS) 1.2.840.10008.5.1.4.1.1.3.1(US MF) 1.2.840.10008.5.1.4.1.1.4 (MR) 1.2.840.10008.5.1.4.1.1.5 (retNM) 1.2.840.10008.5.1.4.1.1.6(retUS) 1.2.840.10008.5.1.4.1.1.6.1 (US) 1.2.840.10008.5.1.4.1.1.7 (SC) 1.2.840.10008.5.1.4.1.1.12.1 (XA) 1.2.840.10008.5.1.4.1.1.12.2 (RF) 1.2.840.10008.5.1.4.1.1.12.3 (RF) 1.2.840.10008.5.1.4.1.1.20 (NM - MF) 1.2.840.10008.5.1.4.1.1.1.1(DX-Prs) 1.2.840.10008.5.1.4.1.1.1.2(MG-Prs) 1.2.840.10008.5.1.4.1.1.1.3(IO-Prs) 1.2.840.10008.5.1.4.1.1.128(PET) 1.2.840.10008.5.1.4.1.1.481.1(RTIMAGE) 1.2.840.10008.5.1.4.1.1.77.1.1(ES) 1.2.840.10008.5.1.4.1.1.77.1.2(GM) 1.2.840.10008.5.1.4.1.1.77.1.3(SM) 1.2.840.10008.5.1.4.1.1.77.1.4(XC)	1.2.840.10008.1.2 1.2.840.10008.1.2.1 1.2.840.10008.1.2.2 1.2.840.10008.1.2.4.70	Explicit VR Little Endian recommended if Private Elements exist in the dataset Return codes = 0000, A700, C000
Fuji Private CR Storage	1.2.392.200036.9125.1.1.2	1.2.840.10008.1.2.1 1.2.840.10008.1.2.4.70	Return codes = 0000, A700, C000
Modality worklist-FIND	1.2.840.10008.5.1.4.31	1.2.840.10008.1.2	See Modality Worklist (Section 3.4) for details
Patient Root Q/R-FIND	1.2.840.10008.5.1.4.1.2.1.1	1.2.840.10008.1.2	Relational queries not supported
Study Root Q/R-FIND	1.2.840.10008.5.1.4.1.2.2.1	1.2.840.10008.1.2	Relational queries not supported
Patient/Study Q/R-FIND	1.2.840.10008.5.1.4.1.2.3.1	1.2.840.10008.1.2	Relational queries not supported
Patient Root Q/R-MOVE	1.2.840.10008.5.1.4.1.2.1.2	1.2.840.10008.1.2 1.2.840.10008.1.2.1	Explicit VR Little Endian will be tried first.
Study Root Q/R-MOVE	1.2.840.10008.5.1.4.1.2.2.2	1.2.840.10008.1.2 1.2.840.10008.1.2.1	Explicit VR Little Endian will be tried first
Patient/Study Q/R-MOVE	1.2.840.10008.5.1.4.1.2.3.2	1.2.840.10008.1.2 1.2.840.10008.1.2.1	Explicit VR Little Endian will be tried first
Storage commitment push	1.2.840.10008.1.20.1	1.2.840.10008.1.2	See Storage Commitment (Section 3.5) for details
Modality Performed Procedure Step	1.2.840.10008.3.1.2.3.3	1.2.840.10008.1.2	See Performed Procedure Step (Section 3.6) for details
	PRINT SCU CLASSES		
Basic Grayscale Print Management Meta SOP Class	1.2.840.10008.5.1.1.9	1.2.840.10008.1.2.1 1.2.840.10008.1.2	
Basic Film Session SOP Class	1.2.840.10008.5.1.1.1		N-CREATE, N-DELETE
Basic Film Box SOP Class	1.2.840.10008.5.1.1.2		N-CREATE, N-DELETE, N-ACTION
Basic Grayscale Image Box SOP Class	1.2.840.10008.5.1.1.4		
Printer SOP Class	1.2.840.10008.5.1.1.16		N-GET
Print Job SOP Class	1.2.840.10008.5.1.1.14		N-GET

- Extended negotiations are not supported for any of the above service classes
- Multi-frame images ARE supported in any of the above storage SOP Classes, where applicable.
- There is no enforced limit on number of associations. System configuration (CPU, memory, Disk) may enforce practical limitations
- Only TCP/IP protocol is supported. Any physical media supporting the TCP/IP protocol is supported.
- AETitle, host (or IP address), port, and maximum PDU size are configurable
- Implementation UID is 1.2.840.113845.1.1, Implementation version is the currently applicable Synapse software release version number.
- Extended character sets ARE supported
- Maximum number of rows the standard CFIND and modality worklist will retrieve is 5000.
- Supported photometric interpretations: MONOCHROME1, MONOCHROME2, PALETTE COLOR, RGB
- Bits allocated greater than 16 are not supported.
- Pixels have to be right justified: high_bit = bits_stored - 1

3. Storing Studies



A modality will use CSTORE service to store images into Synapse.

3.1 Ideal Store scenario

1. Study is ordered in RIS, which assigns a unique identifier to the study. In DICOM terms this unique ID is called the accession number.
2. The modality requests a modality worklist from the DICOM SCP which provides a list of studies to be performed. The list contains all the pertinent study and patient data such that the data does not need to be entered again at the modality. The accession number as well as the study instance UID are also provided to the modality.
3. The modality generates the study and populates the DICOM headers of the images with the correct accession number, study instance UID and patient demographics. The modality also creates a unique series, and SOP instance UIDs as required by the DICOM standard. If a study consists of images from different modalities, each modality will generate a different study instance UID for the same study, then it is only the accession number that will indicate if images from different modalities are to be placed in the same study.
4. The modality sends images to the DICOM SCP using CSTORE operations.
5. The modality verifies that the images have been stored via the Storage commitment service class so that it can delete the images from its own local storage.
6. Finally, the modality indicates that the procedure has been performed via the performed procedure step service class.

3.2 Non-ideal scenarios

Not all modalities support Modality Worklist, performed procedure step, or Storage Commitment. Due to lack of full DICOM support at the modalities several conditions arise:

- If the modality does not support Modality worklist and only allows patient demographics to be entered manually or via a barcode scan, a DICOM SCP has to use other means to determine to which study the image belongs. This is true even if the modality allows manual entry of a medical record number or accession number, but it does not insert it in the DICOM header.
- If the modality has no Modality Worklist support but allows entry of the accession number and inserts it into the DICOM header, the primary concern is that the accession number may be typed incorrectly and consequently the images could be associated with the wrong study.

- If the modality does not indicate that the procedure has been completed (i.e. no support for Performed Procedure Step), then the DICOM SCP has no way to know that all images of a study have been sent. Unless some mechanism is built in the SCP, a PACS system database would potentially wait forever to determine if all images of a study are available. This may adversely effect the way a PACS system determines when studies should be available to a Radiologist for reading. Under such circumstances, Synapse Dicom Server assumes that when the c_store association is closed, it signals the completion of the transmission of a study.

3.2.1 Accession number

If a modality is unable to provide the accession number in the DICOM headers, the Synapse DicomServer attempts to match the incoming study with a pre-ordered study. If it cannot find a match, a new study is created in the Synapse system as a place to hold the images. If Synapse is able to find the patient, it creates the study for that patient. If Synapse is not able to find the patient then it creates a new patient and stores the study. The creation of a new patient in Synapse is not related to creation of a patient in RIS in this case.

The Fuji Synapse DICOM server uses patient name, ID, gender, date, to “best fit” the image to a study. However, this method does not guarantee 100% success rate.

3.2.2 No indication of completion

If an SCU does not support MPPS, the DicomServer can be configured to consider end of c_store association as the completion of transmission of the study.

If a RIS interface is available, it is possible to indicate the end of study via an HL-7 message to the Synapse Server.

3.3 CSTORE

The DicomServer generates a "Refused:Out of resources" response if it cannot write the image to a disk or if it cannot update the Synapse database.

The DicomServer generates a "Cannot Understand" response if the image does not contain Study Instance UID. The following table lists the recommended elements required in the DICOM header, to display images properly:

Attribute	Tag	Comments
Patient name	(0010,0010))	Not required but recommended if Accession number is not present
Patient ID	(0010,0020)	Not required but recommended if Accession number is not present
Accession number	(0008,0050)	Recommended to be present
Study Instance UID	(0020,000D)	Must be present
Modality	(0008,0060)	Must be present
Window Width	(0028,1051)	If not present, an internal algorithm is used
Window Level/Center	(0028,1050)	If not present, an internal algorithm is used
Bits allocated	(0028,0100)	Must be present and must be less than or equal to 16
Bits Stored	(0028,0101)	Must be present
High bit	(0028,0102)	Must be present
Rows	(0028,0010)	Must be present
Columns	(0028,0011)	Must be present
SOP Instance UID	(0010,0020)	Must be present

3.4 Modality Worklist

The following matching keys are supported:

Attribute	Tag	Matching
Scheduled Procedure Step Sequence	(0040,0100)	
>Scheduled Procedure Start Date	(0040,0002)	Single, Range
>Scheduled Procedure Start Time	(0040,0003)	Single, Range
>Modality	(0008,0060)	Wildcard
>Performing Physician Name	(0040, 0006)	Single, Wildcard
Accession Number	(0008,0050)	Single, Wildcard, Universal
Patient Name	(0010,0010)	Single, Wildcard, Universal
Patient ID	(0010,0020)	Single, Universal

- Matching on Scheduled Station AE Title (0040,0001) is not currently supported.

The following return values are supported:

Attribute	Tag	Comments
Scheduled Procedure Step Sequence	(0040,0100)	
> Scheduled station AE Title	(0040,0001)	From query if none available from RIS
>Scheduled Procedure Start Date	(0040,0002)	
>Scheduled Procedure Start Time	(0040,0003)	
>Modality	(0008,0060)	
>Performing Physician Name	(0040,0006)	RIS Attending Physician
>Scheduled Procedure Step Description	(0040,0007)	RIS Procedure Description
>Scheduled Procedure Step ID	(0040,0009)	RIS Procedure Code
Patient Name	(0010,0010)	
Patient ID	(0010,0020)	
Patient Date of Birth	(0010,0030)	
Patient Gender	(0010,0040)	
Accession Number	(0008,0050)	
Study Instance UID	(0020,000D)	Synapse generated UID
Requested Procedure Step ID	(0040,1001)	RIS Procedure Code
Requested Procedure Step Description	(0032,1060)	RIS Procedure Description
Requested Procedure Code sequence	**(0032,1064)**	**NOT SUPPORTED**
> Code Value	**(0008,0100)**	**NOT SUPPORTED**
Requested Procedure Priority	**((0040,1003)**	**NOT SUPPORTED**
Requesting Physician	**(0032,1032)**	**NOT SUPPORTED**
Referring Physician Name	**(0008,0090)**	**NOT SUPPORTED**

3.5 Storage commitment

Storage commitment Request – Action Information

Attribute	Tag
Transaction UID	(0008,1195)
Reference SOP Seq	(0008, 1199)
>Referenced SOP Class UID	(0008, 1150)
>Referenced SOP Instance UID	(0008,1155)

- The SCP deletes SOP instances only when there is no space for new images. In that case, the images will be deleted only if the System is configured to do so. New images are refused if there is no space for new images and deletion is not explicitly enabled.
- All images are committed to disk during the CSTORE operations.
- Application Profiles, Storage Media File-Set ID and UID attributes are not supported.

Storage commitment Result – Report, No failures

Attribute	Tag
Transaction UID	(0008,1195)
Reference SOP Seq	(0008, 1199)
>Referenced SOP Class UID	(0008, 1150)
>Referenced SOP Instance UID	(0008,1155)

Storage commitment Result – Report, Failures

Attribute	Tag
Transaction UID	(0008,1195)
Reference SOP Seq	(0008, 1199)
>Referenced SOP Class UID	(0008, 1150)
>Referenced SOP Instance UID	(0008,1155)
Failed SOP sequence	(0008,1198)
>Referenced SOP Class UID	(0008,1150)
>Reference SOP Instance UID	(0008,1155)
> Failure reason	(0008,1197)

- N-EVENT-REPORT is generated in response to the storage commitment request, as specified in the DICOM standard. Upon receipt of the storage commitment request, the SCP will check the Synapse database for the specified SOP instances and generate the result response
- Storage Media file-set ID & UID attributes are not supported
- Application profiles are not supported
- The Retrieve AE title is not supported. An SCU must explicitly use the supported Query/Retrieve models to retrieve such information
- N-EVENT-REPORT will be sent immediately after receiving the N-ACTION message on a separate association but BEFORE the response to N-ACTION is sent. SCUs must be able to handle the request for a separate association.

3.6 Performed procedure step

N-CREATE required attributes

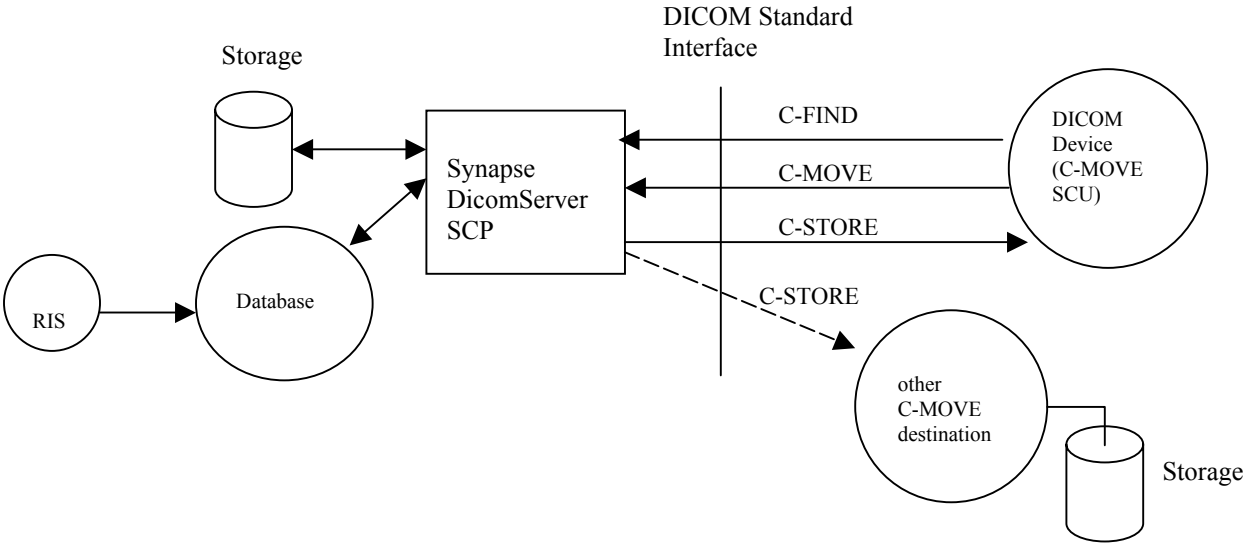
Attribute	Tag
Scheduled Step attribute Sequence	(0040,0270)
>Study Instance UID	(0020,000D)
Performed procedure step ID	(0040,0253)
Performed station AE Title	(0040,0241)
Start date	(0040,0244)
Start time	(0040,0245)
Status	(0040,0252) Must be "IN PROGRESS"
Modality	(0008,0060)

N-SET supported attributes, items in italics must be supplied to properly execute N-SET

Attribute	Tag
Scheduled Step attribute Sequence	*(0040,0270)*
>Study Instance UID	*(0020,000D)*
Performed procedure step ID	*(0040,0253)*
Status	(0040,0252) No changes after COMPLETED or DISCONTINUED

4. Retrieving Studies

Any DICOM-compliant device can retrieve studies from Synapse via the supported Query/Retrieve SOP classes.



The Synapse DicomServer supports the following two Q/R service classes

- Patient Root (CFIND, CMOVE)
- Study Root (CFIND, CMOVE)

Relational queries are not supported.

4.1 C-Find

Supported levels

Q/R model	Supported query levels	Operation
Patient Root	Patient, Study, Series, Image	Unique keys for higher levels are required for lower level queries
Study Root	Study, Series, Image	Unique keys for higher levels are required for lower level queries

- As specified in the DICOM standard, in order to retrieve information at lower levels, unique keys for higher levels must be specified. These unique keys for the levels higher than the query level can be obtained by first performing a C-FIND at that same query level. For example, Patient, Study and Series C-FIND operations must be performed to obtain the unique keys for a Image level query in the Patient Root model.

4.1.1 Matching attributes

Patient Level Attributes

Attribute	Tag
Patient Name	(0010,0010)
Patient ID	(0010,0020) - Unique

Study Level Attributes

Attribute	Tag

Study Date	(0008,0020)
Study Time	(0008,0030)
Accession number	(0008,0050)
Referring Physician	(0008,0090)
Study ID	(0020,0010)
Study Instance UID	(0020,000D) - Unique

Series Level Attributes

Attribute	Tag
Modality	(0008,0060)
Series number	(0020,0011)
Series Instance UID	(0020,000E)- Unique

Image Level Attributes

Attribute	Tag
Image Number	(0020,0013)
SOP Instance UID	(0008,0018) - Unique

The following matching criteria are supported:

- Wildcard matching (* or ?) for the level of the query (except for date and time)
- Range matching (for dates and time)
- Universal matching (data is returned but not used in match)
- UID list matching

4.2 C-Move

The Synapse DicomServer supports the following C-MOVE models as specified by the DICOM standard.

Supported levels

Q/R model	Supported retrieve levels	Operation
Patient Root	Patient, Study, Series, Image	Unique keys for higher levels are required for lower level queries
Study Root	Study, Series, Image	Unique keys for higher levels are required for lower level queries

4.2.1 Matching Attributes

In contrast to the case of C-FIND, only the unique attributes are matched against in a C-MOVE query, i.e.

Patient Level Attributes

Attribute	Tag
Patient ID	(0010,0020) - Unique

Study Level Attributes

Attribute	Tag
Study Instance UID	(0020,000D) - Unique

Series Level Attributes

Attribute	Tag
Series Instance UID	(0020,000E)- Unique

Image Level Attributes

Attribute	Tag
SOP Instance UID	(0008,0018) - Unique

The matching criteria are more restrictive than they are in the case with C-FIND. At all levels above the retrieve level, only single value matching is allowed. At the retrieve level, only single value and list-of-UID matching are allowed. For example, if a patient-root retrieve is requested with a retrieve level of 'series', the SCU must supply single values for the patient ID and Study Instance UID, but could supply either a single or a list of series instance UIDs.

The actual transmission of the matched results takes place on a separate C-STORE association between the Synapse DicomServer and the move destination (which is not necessarily the C_MOVE SCU) and it is done one image at a time. In negotiating the C_STORE association with the C_MOVE destination, little endian explicit transfer syntax is always attempted first, if it fails, then little endian implicit transfer syntax is attempted.

No pending status response is sent to the SCU while images are being transmitted. A final response will be issued when the entire operation has completed. In the final C-MOVE response, the number of completed sub-operations and number of failed sub-operations are indicated, with a data set containing the list of failed SOP Instance UIDs if appropriate. The number of remaining sub-operations and the number of warning sub-operations are absent as we do not keep track of those figures.

Synapse DicomServer does not handle the C_MOVE_CANCEL indication. Once the C_MOVE operation has started, it will continue until completion.

5. Dicom Print SCU

The Synapse system includes standard printer drivers to provide an interface to various Dicom printers. The Dicom Print SCU is part of the Synapse Workstation.

5.1 Overview

A Synapse Workstation formats one or more images on a page to be printed. The Workstation sends each page to the dicom printer as a basic 8-bit grayscale image box. An association is created for each print job and closed at the completion of the job. Print jobs are queued so each printer has one active association open at a time. Windows NT allows multiple printers to be active, so there is no fixed maximum number of associations.

5.2 Required SOP Classes

The print driver uses the Basic Grayscale Print Management Meta SOP Class.

SOP Class Name	Class UID	Service Group
Basic Grayscale Print Management Meta SOP Class	1.2.840.10008.5.1.1.9	
Basic Film Session SOP Class	1.2.840.10008.5.1.1.1	N-CREATE, N-DELETE
Basic Film Box SOP Class	1.2.840.10008.5.1.1.2	N-CREATE, N-DELETE, N-ACTION
Basic Grayscale Image Box SOP Class	1.2.840.10008.5.1.1.4	
Printer SOP Class	1.2.840.10008.5.1.1.16	N-GET
Optional:		
Print Job SOP Class	1.2.840.10008.5.1.1.14	N-GET

5.3 Optional SOP Classes

The Print Job SOP Class (1.2.840.10008.5.1.1.14) is optional. If supported it is used to monitor completion of the print job through the N_GET Service Group.

5.4 Supported Dicom Attributes

The SCU can support the following attributes. Individual printer drivers may support a subset of these options.

Attribute	Tag	Supported Options
Copies	(2000,0010)	
Priority	(2000,0020)	HIGH, MED, LOW
Medium Type	(2000,0030)	PAPER, CLEAR FILM, BLUE FILM
Film Destination	(2000,0040)	MAGAZINE, PROCESSOR, BIN_i
Film Session Label	(2000,0050)	
Image Display Format	(2010,0010)	STANDARD\1,1
Film Orientation	(2010,0040)	PORTRAIT, LANDSCAPE
Film Size	(2010,0050)	Display
		8INX10IN, 10INX12IN,10INX14IN,
		11INX14IN, 14INX14IN, 14INX17IN
		24CMX24CM, 24CMX30CM
Magnification Type	(2010,0060)	REPLICATE, BILINEAR, CUBIC, NONE
Smoothing Type	(2010,0080)	SHARP, SMOOTH, MEDIUM
Border Density	(2010,0100)	BLACK, WHITE, 0-300

Empty Image Density	(2010,0110)	BLACK, WHITE, 0-300
Min Density	(2010,0120)	0-300
Max Density	(2010,0130)	0-300
Trim	(2010,0140)	YES, NO
Polarity	(2020,0020)	NORMAL, REVERSE
Bits stored	(0028,0101)	8
Bits allocated	(0028,0100)	8
Printer configuration table	(2010,0150)	CS000-CS999
Printer Status	(2110,0010)	NORMAL, WARNING, FAILURE
Printer Status Info	(2110,0020)	
Execution Status	(2100,0020)	PENDING, PRINTING, DONE, FAILURE